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To

my mother, my dear children, and my  
sister, and my wife's mother, and to the  
many friends who have so kindly and willingly  
aided me in the completion of this work.



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Genetics of Protein Synthesis in Soybeans

Genetics of Protein Synthesis in Soybeans  
and the Role of Protein in Plant Growth  
and Development

By

James Byron Gooding

June, 1965

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Soybean Improvement Agency

Controlled crosses were made using inbred lines of soybeans selected on the basis of variations in protein content. The  $F_2$  generation was planted in a randomized block design at two locations with two replications of each treatment. Each replication contained 10 inbred lines produced by selfing and the 10 progeny obtained by crossing the five lines in all possible combinations.

Total protein (N x 6.25) was determined by rapid micro-Kjeldahl technique. Statistical analysis indicated protein content is influenced by the presence of dominant genes for low protein with evidence of maternal influence. It is influenced by environment. Regression analysis indicated no linear relationship between total protein (N x 6.25) and total protein.

Analysis of lysine inheritance was based upon a conventional solid analysis of samples representing a complex

in the same way as in the case of the linear regression method. The results of the regression analysis are shown in Table 1. A close relationship exists between lysine and total essential amino acids with a very low correlation coefficient. A low correlation exists between lysine and total amino acids. A positive correlation exists between lysine and methionine and threonine.

Orthogonal regression for proteins and a rapid quantitative analysis technique proved unreliable when used in amino acids. The cause of this unreliability was studied.



## INTRODUCTION

### The Protein Problem

Cereals and cereal grains are the major source of protein in human diets while legumes and animal products are supplemental sources. Most (1951) reports cereals and cereals contribute 43% of the total dietary protein in most African diets while also contributing up to 70% of the total dietary protein in the Far East. Importance of the contribution of cereal grains to the dietary protein of Latin America is emphasized by the fact that in some regions it is the staple grain while in others corn is the staple grain on the diet. Albrecht (1945) estimates that Africa produced more protein for human consumption than all animal and legume sources combined. The importance of protein quality and quantity in cereal grains is secondary to the importance of animal products where animal products are the major source of protein.

The prominence of cereal grains as a major protein source in human diets and problems which are inherent have not previously been so well illustrated. Now (1951) (1953) (1954) show where sufficient cereals to satisfy the caloric

of the protein (protein, free amino acids or amino acids) present in the feed. (i) and (ii) are concerned with the use of protein supplements in the feed to assist protein synthesis. (iii) refers to the feed being used as a whole grain material. (iv) refers to the feed being used in one or more animal feeds. Thus, for example, as the primary feeding source and/or as a feed supplement. Therefore as special feeding sources in cases where triphosphate and lysine are co-ingredients (Table II).

A dominant problem is the loss of protein during processing. The principal source of this loss is through cooking where the heat, which is proportionally higher in grains than the endosperm, or the seed coat, including the embryo layer, may be removed. Loss of either or both of these two fractions lowers both the quality and the quantity of protein in the finished product.

Widespread degrees of protein malnutrition often results in the poorest areas of the world where the average diet consists of cereal grains of low nutritive value supplemented with small amounts of animal or legume proteins. Thus form malnutrition is debilitating in adults. In pre-school children whose protein needs are high in relation to caloric requirements, severe cases of protein malnutrition result in the permanent impairment of mental capacity. The caloric requirement may be met with a cereal-based diet after weaning, but protein deficiency will result unless sufficient





improved protein balance from plant sources can be achieved through a diet of plant foods that complement one another's essential amino acids. A cereal-legume mixture, including soybeans, eaten in proper balance will often fulfill many essential/requirements (Johnson *et al.*, 1940). However, common misconceptions and lack of understanding of nutritional limitations frequently rule out food combinations as a viable approach to improved diets. Moreover, children are restricted during their most critical stage of development to what is available in the home.

Improved protein balance can also be accomplished by supplementing amino acids in processed foods. The difficulty of this approach is implementation of the program (a) people in greatest need of such a program already are consuming little commercially processed food; it is either unavailable or too expensive.

Another situation, which also has limitations, is the improvement of protein quality and quantity in cereal grains. Several approaches have been suggested by some (1) part of which are based upon selection and breeding; (2) part is a program of quality improvement and to maintain the proper balance between essential and non-essential amino acids in the grain and (3) avoid selection of strains without regard to total composition (H. J. H. H. H., 1944). A third practical approach to quality and acceptability would also be appropriate in

and/or low reproduction with high protein even and high amino acids.

### Protein Production in the Pigeon

From 1940 to 1950 over two half century of breeding from the increased production with little or no improvement in nutritional quality. Kamen (1971) attributes this lack of progress to a general lack of understanding of the physiological requirements of avian species and the inadequacy of simple, quantitative, laboratory-based quantitative assay screening methods to test in the field for effective materials. A general lack of knowledge of the importance of cereal grains and subleaves in the diets of developing culivores and the contribution to their nutrition.

There is the improvement of protein in some cereal grains early in the twentieth century. Mendelish et al. (1944) reported on the results of 50 generations of selection for protein and all variants in corn and shortly afterward (1947, 1948) published on the inheritance of protein content. These studies indicate crude protein could be increased in corn but no serious work was begun since the problem was largely in the form of nutritionally poor mixtures of the opaque-2 and the flinty-2 genes which conditionally alter the amino acid patterns in maize (1949, 1950, 1951) created renewed interest in the role of proteins in cereal grains.

improving the quality and the quantity of feeding  
of cereal grains has attracted increasing attention since the  
1950s. The International Rice Research Institute  
early concentrating on the variability of protein content  
of rice varieties of early isolines at Phil. 1944 and later  
concentrated on high protein rice varieties (Solano  
1954) (1961). The Philippine Agricultural Experiment Station  
concentrated on improved low-land selections of wheat for  
nitrogen-protein and lysine differences. The data indicate  
significant increase in protein content of wheat can be  
achieved without sacrificing yield (Solano at al.,  
1961). Lower yield in high protein lines has been the major  
problem in the introduction of high protein commercial  
varieties. A breeding program was begun at Purdue University  
to improve protein quality and quantity in that crop,  
the result of this program was the discovery of a high  
lysine wheat gene (Hays and Kester, 1971). A broad-based  
program designed to upgrade protein quality and quantity  
of cereal grains was also developed in India (Bhowmik  
1972) (1971).

The inferior quality of cereal proteins is attributed  
to the deficit among the protein fractions in the grain  
composition low in lysine content constitute the major por-  
tion (40-60%) of seed proteins in most cereals, with  
10-15% of intermediate lysine content constituting most  
of the remainder. The smallest protein fraction in cereals

of the amount of amino acid incorporation in a given cell culture. Mutation in  $\text{trp}^+$  ( $\text{trp}^+$   $\text{trp}^+$ ) of *Escherichia coli* (Belen, 1970). These definitions of amino acid content along various protein fractions of the cell would be possible if improvement through selection, which would suppress the synthesis of protein (amino acid) is too desired amino acids with a composition of synthesis of other fractions with higher levels of the amino acids.

Protein of amino acids is regulated to correspond directly to demand for incorporation into proteins by the cell. Therefore, normal growth contains very low quantities of free amino acids (Belen, 1970). An induced or spontaneous mutation causing a loss of sensitivity to control of amino acid synthesis could cause an over-synthesis with a resulting increase in free amino acids. An example of this type has been identified to date (Belen, 1970).

The most promising types of mutations are those which involve some change in the structural components of the molecule or need structure. The high lysine mutants in *Escherichia coli* are of this gross structural change type. Theoretically, mutation in the high lysine gene, inhibits the cyclic amino acid. The production function of the protein, is amino acid. The mutations in which one amino acid is substituted for another in protein synthesis have not been identified in changing protein quality and quantity.



transformationally appears in the composition of the genome. It is noted that significant changes in the amino acid composition of cereal proteins could suggest beneficial mutations. More specifically these suggest the following mutations which reduce synthesis of the seed storage proteins fraction and increase synthesis of some protein fractions (Johnson et al., 1948; Bower, 1951; Bower and Davis 1948, 1949) found a significant correlation with the protein fraction of seed protein, reduced protein composition for either the opaque-2 or the opaque gene with a corresponding increase in lysine. Bower et al. (1948) found the same effect when the opaque-2 gene was incorporated into various strains of corn. Bower, Bower, Davis and Chang (1948) studied the effect of amylose, protein and lysine content is done by incorporating a gene conditioning multiple aleurone cell layers, which is also known as lysine.

Significant improvement in protein quality or quantity in cereal grains can be accomplished through selection and breeding and by creating mutations, either spontaneous or induced. Manipulation of major genes offers the most efficient and the most rapid method of increasing protein quantity or quality but generally major genes are not available. Selection and breeding hold the most promise for protein improvement when sufficient variability is available. The researcher can attempt to induce mutations

and will be used for official representation of the  
 1957-1958 season and will be used in the 1959-1960  
 season (possibly 1961) as an experimental season  
 and for official use. The 1959-1960 season will also  
 be used for official use in the 1960-1961 season.

Protein which is produced in the total protein in the  
 embryo during these years is the grain should be con-  
 sidered as well as the form at which the grain is consumed  
 differences in structural components of the seed have a  
 major influence on their ability to transmit genetically  
 improved protein and amino acid potentials. Milling pro-  
 cedures and feeding methods may remove portions of the seed  
 which are highest in good quality protein. Cultural prac-  
 tices may also significantly alter both the quality and the  
 quantity of protein in the endosperm. Chaffey and Roth,  
 1961

Protein in the grain are much superior to protein  
 quality in those of the endosperm. Chaffey, 1960, therefore,  
 increasing the relative size of the embryo for quality and  
 quantity of protein in the grain would be of importance when  
 the grain is consumed. He studies have been made to  
 assess the possibility of significantly changing the  
 amino acid composition of the embryo but it has been noted  
 that both the Lysine-2 and the Lysine-3 genes of maize  
 increase embryo size when incorporated into new lines.

1971) and the effect of pH (Gordon and Bunting 1971).

The present work demonstrates that in some cases quality can be significantly improved by continuous irrigation, reducing the thickness of the  $\alpha$ -glucanase-rich layer and its contact with the quartz and the resulting damage to the grains. The improved protein quality of the irrigated grain is made as follows: (a) by the increased thickness of the  $\alpha$ -glucanase layer (Table 1); (b) by the increased thickness of the  $\alpha$ -glucanase layer (Table 1);

however quality of cereal proteins may be determined by the small fraction of globulins which are high in lysine and the large fraction of prolamins of low lysine content. Prolamins are abundant in the  $\alpha$ -glucanase layer and the endosperm, while globulins are found in the endosperm. Any factor which significantly alters the ratio of these protein fractions will have significant effects on the protein quality and nutritive value of the grain.

One aspect of the problem mentioned is the breeding of cultivars in the lack of a simple, quantitative, non-destructive method of analysis for total protein and amino acids.

Protein analysis techniques have been developed which measure protein in some cereal grains. By 1971 developed a technique originally for wheat and later expanded it to

method (1966) for the rapid estimation of protein content in wheat grain. The method involves the use of a modified Kjeldahl method for the rapid estimation of protein in grain. The method involves the use of a modified Kjeldahl method to estimate the high levels of nitrogen in grain. (1966) described a method of rapid estimation of protein content in grain using a modified Kjeldahl method. (1966) reported a rapid method for estimation of protein in grain. (1966) and (1966) found a high correlation using various methods including Kjeldahl, Dumas, and micro-Kjeldahl methods. (1966) and (1966) described a rapid micro-Kjeldahl procedure in which digestion is completed within 15 minutes.

The major problem confronted in the search for a rapid analytical technique for protein or total amino acids is hydrolysis. Standard methods require special equipment and a great deal of time. (1966) and (1966) described a variety of hydrolysis procedures in which up to 100 samples per week may be processed, but even this method is not entirely free of the requirements of a breeding program in which thousands of segregating genotypes must be analyzed.

Modern analytical methods for protein include micro-Kjeldahl (1966), (1966), and (1966), and thin-layer chromatographic techniques (1966 and 1966).

- (1)  $\mu_1 = \mu_2 = \dots = \mu_n = \mu$  (uniform distribution).
- (2)  $\mu_1 = \mu_2 = \dots = \mu_n = \mu$  (uniform distribution).

## Food Production Of South America

### PERU: THE COMMONS OF THE PERUAN COAST

Maize is a robust annual bushgrass grown as a major backbone as a grain crop for human consumption (Kemp and Powell, 1961; Barker et al., 1972). It is adapted to the tropics and will grow and secure seed in soils too infertile and too dry for other grain crops. It is highly productive in the dry, infertile areas of the commons but made it a major food source. Good nutritional quality of the grain justify the research in production and improvement of this crop presently being advanced (Kemp, 1969).

Maize has a protein content ranging from 4.5% to 11.5% with lysine varying from 1.7% to 2.9% of the protein (Kemp et al., 1972; Wallace, unpublished data). It is an approximate with those of *Sorghum* et al., 1972). The protein, with lysine ranging from 1.7% to 2.9% of the protein, and tryptophan ranging from 0.1% to 0.3% of the protein. Lysine occurs during milling. Approximately 80% of the proteins in the whole grain usually remain after processing (Kemp, 1969).

With 8 1/2% content and balance of minerals it follows  
 as we expect to be better than most other minerals. (Table 1)  
 This is being tried now, about, by using as fat and protein  
 sources. (Table 2)

Energy and glucose potential has not been established,  
 and there is evidence to suggest peroxidation yields may  
 increase markedly with some and perhaps other good nutri-  
 tion including use of adapted varieties, irrigation, and  
 fertilizers was practiced (Barton and Powell, 1958; Barton  
 et al., 1959).

Purposes of this study were (I) to determine the  
 suitability of protein and lysine, the primary limiting  
 amino acid, in the diets of peroxidized and (II) to investi-  
 gate the nutritive and adaptability of peroxidized of use  
 from comparative methods of analysis reported as the  
 literature for protein and lysine.

TABLE 2

OIL AND MINERAL COMPOSITION OF  
NON-CERIAL GRAINS

Grain	Oil %	Ca ppm	P ppm
Wheat (hard)	4.3	46	714
Wheat (soft)	3.8	64	279
Rice	2.5	32	338
Barley—oats	3.5	51	371
Peas	1.2	28	437

TABLE 3  
Composition of Soils, USDA Agricultural Handbook 60, 18



## MATERIALS AND METHODS

### The Bialkali Crops

The Bialkali crops were made during the summer of 1937. The Bialkali Seed Crop recovered from Tifton, Georgia. The seed was selected on the basis of variation in protein and lysine content recommended by Hallam and Black (unpublished) in 1936, in Table 1.

TABLE 1  
PROTEIN AND LYSINE CONTENT OF SEEDS CHOSEN  
USED IN THE BIALKALI CROPS

Seed	Protein	Lysine
	%	(as % protein)
10-1	14.24	2.74
10-2	15.36	2.78
10-3	16.12	2.93
10-4	16.36	2.76
10-5	16.12	2.75
10-6	16.12	2.66

Progeny from the diallel crosses were planted in a split plot design with two locations with two replicates at each location. Replicates contained the six inbred lines produced by crossing the parental lines and the 36  $F_2$ 's (including reciprocals) derived by crossing the six lines in all possible combinations.

Location I was planted on the Agronomy Farm at the University of Florida, Gainesville. Each plot consisted of three rows 3.3 m in length, with 1 m between rows. Plants were spaced approximately 0.5 m apart in the rows. The application of 400 kg/ha or 10-10-10 fertilizer was broadcast before planting. Seeds from the center row of each plot were randomly selected and bagged with a kraft bag and an aluminum screen protector bag to minimize bird damage. Seeds remained on the plants until they were fully matured.

Location II was planted the same season (summer, 1974) on the Hortons Farm, University of Florida Experiment Station, Delray Beach, Florida. Plots were bedded due to the high water table in this area and covered with black plastic to minimize weed competition. The beds were approximately 30 cm high and 3.3 m wide. The plots were fertilized with 400 kg/ha of 10-10-10 fertilizer broadcast prior to bedding. Each plot consisted of two rows 30 cm apart and 3.3 m long planted upon the bed. Plants were spaced approximately 0.5 m apart in the rows. Bedding and covering the beds with plastic minimized interspecific competition. Seeds from both

and stems collected and randomly selected and freeze-dried, ground, and stored in a desiccator until use. Leaves, stems, and roots from the same plants were freeze-dried and stored until they were fully collected. All collected leaves were harvested and then freeze-dried, ground, and stored from each plot for use in the quantitative amino acid analysis and lysine. Line 1-14 and its primary and secondary (14) to post-germination and post seed test (14) were used.

### Analytical Procedures

Quantitative analysis of seed from each of the three levels of the experiment was used for estimation of the plot mean for lysine and lysine. Samples were ground in a Wiley hammer mill, passed through a 40 mesh and oven dried for 24 hours at 60°C for analysis. Samples used in the analysis for lysine and the lysine-binding capacity (LBC) technique for estimation of protein were further refined in a mill and ground (more approximately 1 ml acetone as a wetting agent).

### Lysine Analysis

Lysine (4 x 4 24) was determined by the rapid method (14) procedure described by Gerson and Salinas (1970). Approximately 1.1 g of  $K_2PO_4$ /mg mixture and 1.1 ml  $H_2PO_4$  were added to a ground sample of 54 mg. The mixture was ground until frothing occurred (less approximately 1 ml of 1%  $H_2PO_4$  added). Heating at a lower temperature, approximately



analysis and control of the effects of environmental factors on the growth of the plant. The analysis of variance was performed by using the analysis of variance technique as described in the literature. The analysis of variance was performed at 1% level to distinguish the effects of the treatments. The results of the analysis of variance were visually apparent. The results of the analysis were verified by correlating the results of the analysis with the results of the analysis.

### Statistical Analysis

The data were analyzed using Griffing's (1964) method 1 in which all  $\tau_{ij}$  are used. Model 1 (all effects except error are considered fixed) for estimation of general combining ability (GCA) and specific combining ability (SCA) is provided. Method 2, model II, in which all  $\tau_{ij}$  are considered random variables, was used to estimate heritability with the formula for the general combining ability ( $\sigma^2_{GCA}$ ) modified to include the reciprocal of the variance ( $\sigma^2_{SCA}$ ). Estimates of heritability ( $h^2$ ) as well as the variance were calculated.

The data were analyzed by the Duncan (1964) method of statistical cross analysis for estimation of genetic effects. Free action parameters estimated by this method include the variance, covariance, and selected effects.

## RESULTS

### Parental Investment

A highly significant difference was found between sexes. All other parameters were non-significant (Table 7). Location differences were non-significant but observation of mean values of parents compared across locations (Table 4) suggests the environmental effect upon parents was variable in both the positive and the negative directions masking possible location effects.

Table 2 and 3 contain the means of each cross (by location) arranged with the related parents forming the diagonal. In this format reciprocals are also located diagonally from one another. Reciprocal differences in some lines are apparent.

### Cytoplasmic Inheritance

Data at both locations were subjected to analysis of variance for combining ability (Tables 4 and 5). Estimates of Gk and GkR differed with the reciprocals showing no significant differences between locations. Parental reciprocal estimates ( $R^2_{ij}$ ) (Tables 10 and 11) estimate the major reciprocal differences of approximately the same magnitude







TABLE 3  
 MEAN PERCENT CONTENT IN ALL TISSUES  
 OF A HARPPL CROOK, CRIMMIS (1961)

Tissue	Radioisotopes				Total
	$^{131}\text{I}$	$^{90}\text{Sr}$	$^{144}\text{Sm}$	$^{137}\text{Cs}$	
Adipose	18.42	13.93	15.65	15.45	63.45
Brain	19.75	17.46	14.43	14.35	66.00
Colon	11.75	18.83	21.13	17.88	70.59
Heart	13.48	11.56	17.33	16.59	59.06
Liver	18.65	15.86	17.98	18.34	70.83

TABLE 4

Mean (SD) values of six subjects  
at different times, after birth

Time after birth	Mean (SD)				
	1-2	3-12	13-24	25-36	37-48
Weight	14.98	16.71	18.94	19.82	19.75
Height	29.51	32.88	34.78	36.51	37.27
Head	13.22	13.79	13.46	13.23	13.46
Arm	16.32	16.34	17.41	18.41	18.74
Forearm	15.58	15.23	14.38	14.52	15.25

Weight value estimated by Harris method (Hochman and Cox, 1967)

TABLE 7

ANALYSIS OF VARIANCE FOR PROTEIN OF PROTEIN  
 REDUCING FROM A DIALLYL CYCLO WITH FIVE TREATED SAMPLES

Source	df	SS
Location	1	12.545
Error (a)	3	5.544
Groups	24	28.321**
Replicates & Groups	24	8.873
Error (b)	48	4.45

\*\*Significant at .01.

TABLE II

ANALYSIS FOR COMBING ABILITY FOR  
PROTON, SACKSVILLE

ANALYSIS	wt	wt %
ANALYSIS		
ANALYSIS	4	3.15
ANALYSIS	8	3.18
ANALYSIS	16	4.15
ANALYSIS	48	1.14

Table 2

Estimated Available for Combining Available for  
Program, Budget Base

	85	86
Available for Combining		
General	4	3,954
Special	2	8,875
General	10	4,110
Special	40	2,100

Estimated at 85-

Estimated at 86-

(Cont.) 10

CONTINUED ON P. 11, GSA, AND SCOTSMOOR VALLEY-08  
 (SEE PAGE 11, FACE FAR ST., AND ENVIRONMENTAL  
 RECORD-BOOK FOR 1 WELL, BATHORY-08)

WELL	DATE	ELEVATION (FEET)		
		TO	FROM	DIFF.
10-1	8-10-74	0.0000	1.4210	0.1200
10-27	8-12-74	0.5100	4.5437	0.1100
10-33	8-11-74	1.8100	8.8887	0.1100
10-34	8-10-74	0.8100	8.3713	0.1100
10-35	8-11-74	0.5000	1.8430	0.1100

Table 1

VALUES OF  $\alpha$ ,  $\beta$ ,  $\gamma$ , AND  $\delta$  FOR ALL VERTICAL  
 LINES IN THE CASE OF  $\alpha$ ,  $\beta$ , AND  $\gamma$  FOR ALL  
 LINES IN THE CASE OF  $\alpha$ ,  $\beta$ , AND  $\gamma$

$\alpha$	$\beta$	$\gamma$	$\delta$	$\epsilon$
1	1.4125	1.3508	0.9854	0.0000
2	1.4125	1.3508	0.9854	0.0000
3	1.4125	1.3508	0.9854	0.0000
4	1.4125	1.3508	0.9854	0.0000
5	1.4125	1.3508	0.9854	0.0000
6	1.4125	1.3508	0.9854	0.0000
7	1.4125	1.3508	0.9854	0.0000
8	1.4125	1.3508	0.9854	0.0000
9	1.4125	1.3508	0.9854	0.0000
10	1.4125	1.3508	0.9854	0.0000
11	1.4125	1.3508	0.9854	0.0000
12	1.4125	1.3508	0.9854	0.0000
13	1.4125	1.3508	0.9854	0.0000
14	1.4125	1.3508	0.9854	0.0000
15	1.4125	1.3508	0.9854	0.0000
16	1.4125	1.3508	0.9854	0.0000
17	1.4125	1.3508	0.9854	0.0000
18	1.4125	1.3508	0.9854	0.0000
19	1.4125	1.3508	0.9854	0.0000
20	1.4125	1.3508	0.9854	0.0000
21	1.4125	1.3508	0.9854	0.0000
22	1.4125	1.3508	0.9854	0.0000
23	1.4125	1.3508	0.9854	0.0000
24	1.4125	1.3508	0.9854	0.0000
25	1.4125	1.3508	0.9854	0.0000
26	1.4125	1.3508	0.9854	0.0000
27	1.4125	1.3508	0.9854	0.0000
28	1.4125	1.3508	0.9854	0.0000
29	1.4125	1.3508	0.9854	0.0000
30	1.4125	1.3508	0.9854	0.0000
31	1.4125	1.3508	0.9854	0.0000
32	1.4125	1.3508	0.9854	0.0000
33	1.4125	1.3508	0.9854	0.0000
34	1.4125	1.3508	0.9854	0.0000
35	1.4125	1.3508	0.9854	0.0000
36	1.4125	1.3508	0.9854	0.0000
37	1.4125	1.3508	0.9854	0.0000
38	1.4125	1.3508	0.9854	0.0000
39	1.4125	1.3508	0.9854	0.0000
40	1.4125	1.3508	0.9854	0.0000
41	1.4125	1.3508	0.9854	0.0000
42	1.4125	1.3508	0.9854	0.0000
43	1.4125	1.3508	0.9854	0.0000
44	1.4125	1.3508	0.9854	0.0000
45	1.4125	1.3508	0.9854	0.0000
46	1.4125	1.3508	0.9854	0.0000
47	1.4125	1.3508	0.9854	0.0000
48	1.4125	1.3508	0.9854	0.0000
49	1.4125	1.3508	0.9854	0.0000
50	1.4125	1.3508	0.9854	0.0000
51	1.4125	1.3508	0.9854	0.0000
52	1.4125	1.3508	0.9854	0.0000
53	1.4125	1.3508	0.9854	0.0000
54	1.4125	1.3508	0.9854	0.0000
55	1.4125	1.3508	0.9854	0.0000
56	1.4125	1.3508	0.9854	0.0000
57	1.4125	1.3508	0.9854	0.0000
58	1.4125	1.3508	0.9854	0.0000
59	1.4125	1.3508	0.9854	0.0000
60	1.4125	1.3508	0.9854	0.0000
61	1.4125	1.3508	0.9854	0.0000
62	1.4125	1.3508	0.9854	0.0000
63	1.4125	1.3508	0.9854	0.0000
64	1.4125	1.3508	0.9854	0.0000
65	1.4125	1.3508	0.9854	0.0000
66	1.4125	1.3508	0.9854	0.0000
67	1.4125	1.3508	0.9854	0.0000
68	1.4125	1.3508	0.9854	0.0000
69	1.4125	1.3508	0.9854	0.0000
70	1.4125	1.3508	0.9854	0.0000
71	1.4125	1.3508	0.9854	0.0000
72	1.4125	1.3508	0.9854	0.0000
73	1.4125	1.3508	0.9854	0.0000
74	1.4125	1.3508	0.9854	0.0000
75	1.4125	1.3508	0.9854	0.0000
76	1.4125	1.3508	0.9854	0.0000
77	1.4125	1.3508	0.9854	0.0000
78	1.4125	1.3508	0.9854	0.0000
79	1.4125	1.3508	0.9854	0.0000
80	1.4125	1.3508	0.9854	0.0000
81	1.4125	1.3508	0.9854	0.0000
82	1.4125	1.3508	0.9854	0.0000
83	1.4125	1.3508	0.9854	0.0000
84	1.4125	1.3508	0.9854	0.0000
85	1.4125	1.3508	0.9854	0.0000
86	1.4125	1.3508	0.9854	0.0000
87	1.4125	1.3508	0.9854	0.0000
88	1.4125	1.3508	0.9854	0.0000
89	1.4125	1.3508	0.9854	0.0000
90	1.4125	1.3508	0.9854	0.0000
91	1.4125	1.3508	0.9854	0.0000
92	1.4125	1.3508	0.9854	0.0000
93	1.4125	1.3508	0.9854	0.0000
94	1.4125	1.3508	0.9854	0.0000
95	1.4125	1.3508	0.9854	0.0000
96	1.4125	1.3508	0.9854	0.0000
97	1.4125	1.3508	0.9854	0.0000
98	1.4125	1.3508	0.9854	0.0000
99	1.4125	1.3508	0.9854	0.0000
100	1.4125	1.3508	0.9854	0.0000

parental variance located at both locations. Good lines are not too numerous but 19th, 17th and 17th<sup>2</sup> are among the good ones. Lines 3-23 and 3-27, representing non-selected lines, are inferior to progeny from lines 1-15 and 1-16, however. Differences in combining ability between locations are an indication of the effect of environment as previously defined.

The GCA of each of the five inbred lines in this study, was nonsignificant at Gainesville. Estimates obtained for each parent show line 3-23 superior to all other lines at this location, this being evidenced by the consistency of the progeny in approaching the parental value in protein content (Table 10).

The GCA variance estimate ( $\sigma^2_{\alpha}$ ) associated with each parent indicates lines 3-27 and 3-23 are superior to all other lines tested at that location (Table 11). The most striking difference in the parental GCA variance estimates between locations is that line 3-4 has a negative value at Gainesville. Four lines have negative values at the Gainesville location.

Analysis of GCA shows non-significant effects at Gainesville (Table 11) and a highly significant effect at Delray Beach (Tables 4 and 5). Parental estimates for GCA ( $\sigma^2_{\alpha}$ ) show 1 and 3-18 to be superior to other lines at Gainesville (Tables 4 and 5) and lines 3-27 and 3-23 superior at Delray Beach (Tables 10 and 11).



### 3.2.2.2. *Genetic Variance*

According to the model, the total genetic variance was estimated as the sum of the additive genetic variance ( $\sigma_a^2$ ), dominance genetic variance ( $\sigma_d^2$ ), and the GxE variance ( $\sigma_{g \times e}^2$ ). The total genetic variance was estimated by the formula:

$$\sigma_g^2 = 3\sigma_d^2 + \sigma_a^2 + \sigma_{g \times e}^2$$

where:

$\sigma_g^2$  = total genetic variance,

$\sigma_d^2$  = estimate of DGE,

$\sigma_{g \times e}^2$  = estimate of GGE, and

$\sigma_a^2$  = estimate of additive effects

The phenotypic variance ( $\sigma_p^2$ ) was estimated by the formula:

$$\sigma_p^2 = \sigma_g^2 + \sigma_e^2$$

where:

$\sigma_p^2$  = error

Heritability is then estimated by the formula:

$$h^2 = \frac{\sigma_a^2}{\sigma_p^2}$$

and the narrow sense and

### 3.2.2.2. Protein content

Improving heritability estimates for protein content was hampered due to the negative values of the  $h^2$  estimates (Table 12). Broad-sense heritability, representing variation between locations with a value of 0.88 at Gainsville and 0.54 at Oakley Beach.

### 3.2.2.3. Protein balance

The Hayes (1994) method of diallel analysis indicated dominance for protein content. The negative values of the square were interpreted as indications of dominance for lower protein content (Table 13). The comparison with which the progeny deviated in the negative direction from the mid-parent value (the mean of the parents) for protein content confirms this interpretation.

Analysis of data also indicates no significant effect of location among parental lines. The Hayes (1997) method of interpretation of data reveals a significant maternal effect which is evidenced by significant  $W$ - $W^2$  differences involving both lines.

Table 13

Regression Analysis of the Effect of Various  
Factors on the Profitability of Firms

Source of Variation	df	MS	Quantifiable Variables	F	Probability > F
Between	4	1.750	-0.021	2.181	0.124
Within	8	2.500	-0.463	8.425	0.000
Total (corrected)	12	4.250	0.004	8.180	0.017
Error	44	0.06		0.06	



### Quantitative Infrared Methods

Quantitative infrared methods for lysine are limited in their accuracy and precision. The method of Kohn *et al.* (1978) was used for the quantitative analysis of the rapid analytical technique of Kohn *et al.* (1978). There was no replication, hence statistically valid inference cannot be made. Hypothesis, however, that the technique for verification in further work.

Quantitative analysis of the data (Table 14) indicates a linear relationship exists between lysine and total carbohydrate amino acids but with a very low correlation coefficient. A negative correlation ( $r = -0.49$ ) exists between lysine and protein content with a strong positive correlation between lysine and the sum of anthracene and glyceric acid. Hence, a linear relationship was not indicated between total amino acids and total protein although the data indicate a slight negative correlation may exist.

### Qualitative Analytical Methods

The method for screening samples for protein content as reported by Kohn *et al.* (1978) was unreliable (Table 15) (variances Table 17). The rapid, quantitative analytical technique for lysine reported by Kohn *et al.* (1978) was unreliable (Table 14). The rapid micro-lysine technique reported by Kohn and Giddins (1978) method was accurate and consistent and correlated well ( $r = 0.96$ ) with the amino-lysinol results (Table 18).

1

[illegible]

TABLE 17  
 PERCENT CONTENT OF PRODUCTS  
 FROM A DIALLYL CROSS

Temp., °C.	Time, min.	Ratio products			Total
		1:1	2:1	3:1	
100	150	1.44	1.14	1.54	4.12
100	300	1.44	0.48	1.20	3.12
100	450		0.70	1.20	1.90
100	600			1.70	1.70
100	750				1.40

Table 15

Estimated  $10^3$  kg/ha dry-matter yields (green + straw) from  
 1990-1991 and 1992-1993, comparing the 15, 30, 45 and 60  
 kg N/ha (range) treatments to mean for the  
 0N to 45N range

Year	N rate (kg/ha)	10 <sup>3</sup> kg/ha green + straw yield	10 <sup>3</sup> kg/ha green + straw yield	10 <sup>3</sup> kg/ha green + straw yield	10 <sup>3</sup> kg/ha green + straw yield
1990-1991	0	1.34	48	1.42	2.43
	15	2.01	28	1.39	1.33
	30	1.13	64	1.13	0.91
1991-1992	0	2.48	84	1.56	3.24
1992-1993	0	1.31	61	2.27	4.34
1993-1994	0	1.82	64	2.79	3.33
1994-1995	0	1.55	50	1.56	2.54
1995-1996	0	1.17	33	1.61	2.45
1996-1997	0	1.67	37	2.34	4.08
1997-1998	0	2.88	73	2.38	2.13
1998-1999	0	2.58	88	2.58	1.14
1999-2000	0	1.35	49	1.38	1.45
2000-2001	0	2.80	31	4.13	4.53
2001-2002	0	1.30	46	1.63	2.00

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## TABLE 17

COMPARISON BETWEEN 200 AND 2000-100000  
 (CUMULATIVE SUMS IN, IN FLUCTUATION 1, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96, 102, 108, 114, 120, 126, 132, 138, 144, 150, 156, 162, 168, 174, 180, 186, 192, 198, 204, 210, 216, 222, 228, 234, 240, 246, 252, 258, 264, 270, 276, 282, 288, 294, 300, 306, 312, 318, 324, 330, 336, 342, 348, 354, 360, 366, 372, 378, 384, 390, 396, 402, 408, 414, 420, 426, 432, 438, 444, 450, 456, 462, 468, 474, 480, 486, 492, 498, 504, 510, 516, 522, 528, 534, 540, 546, 552, 558, 564, 570, 576, 582, 588, 594, 600, 606, 612, 618, 624, 630, 636, 642, 648, 654, 660, 666, 672, 678, 684, 690, 696, 702, 708, 714, 720, 726, 732, 738, 744, 750, 756, 762, 768, 774, 780, 786, 792, 798, 804, 810, 816, 822, 828, 834, 840, 846, 852, 858, 864, 870, 876, 882, 888, 894, 900, 906, 912, 918, 924, 930, 936, 942, 948, 954, 960, 966, 972, 978, 984, 990, 996, 1002, 1008, 1014, 1020, 1026, 1032, 1038, 1044, 1050, 1056, 1062, 1068, 1074, 1080, 1086, 1092, 1098, 1104, 1110, 1116, 1122, 1128, 1134, 1140, 1146, 1152, 1158, 1164, 1170, 1176, 1182, 1188, 1194, 1200, 1206, 1212, 1218, 1224, 1230, 1236, 1242, 1248, 1254, 1260, 1266, 1272, 1278, 1284, 1290, 1296, 1302, 1308, 1314, 1320, 1326, 1332, 1338, 1344, 1350, 1356, 1362, 1368, 1374, 1380, 1386, 1392, 1398, 1404, 1410, 1416, 1422, 1428, 1434, 1440, 1446, 1452, 1458, 1464, 1470, 1476, 1482, 1488, 1494, 1500, 1506, 1512, 1518, 1524, 1530, 1536, 1542, 1548, 1554, 1560, 1566, 1572, 1578, 1584, 1590, 1596, 1602, 1608, 1614, 1620, 1626, 1632, 1638, 1644, 1650, 1656, 1662, 1668, 1674, 1680, 1686, 1692, 1698, 1704, 1710, 1716, 1722, 1728, 1734, 1740, 1746, 1752, 1758, 1764, 1770, 1776, 1782, 1788, 1794, 1800, 1806, 1812, 1818, 1824, 1830, 1836, 1842, 1848, 1854, 1860, 1866, 1872, 1878, 1884, 1890, 1896, 1902, 1908, 1914, 1920, 1926, 1932, 1938, 1944, 1950, 1956, 1962, 1968, 1974, 1980, 1986, 1992, 1998, 2004, 2010, 2016, 2022, 2028, 2034, 2040, 2046, 2052, 2058, 2064, 2070, 2076, 2082, 2088, 2094, 2100, 2106, 2112, 2118, 2124, 2130, 2136, 2142, 2148, 2154, 2160, 2166, 2172, 2178, 2184, 2190, 2196, 2202, 2208, 2214, 2220, 2226, 2232, 2238, 2244, 2250, 2256, 2262, 2268, 2274, 2280, 2286, 2292, 2298, 2304, 2310, 2316, 2322, 2328, 2334, 2340, 2346, 2352, 2358, 2364, 2370, 2376, 2382, 2388, 2394, 2400, 2406, 2412, 2418, 2424, 2430, 2436, 2442, 2448, 2454, 2460, 2466, 2472, 2478, 2484, 2490, 2496, 2502, 2508, 2514, 2520, 2526, 2532, 2538, 2544, 2550, 2556, 2562, 2568, 2574, 2580, 2586, 2592, 2598, 2604, 2610, 2616, 2622, 2628, 2634, 2640, 2646, 2652, 2658, 2664, 2670, 2676, 2682, 2688, 2694, 2700, 2706, 2712, 2718, 2724, 2730, 2736, 2742, 2748, 2754, 2760, 2766, 2772, 2778, 2784, 2790, 2796, 2802, 2808, 2814, 2820, 2826, 2832, 2838, 2844, 2850, 2856, 2862, 2868, 2874, 2880, 2886, 2892, 2898, 2904, 2910, 2916, 2922, 2928, 2934, 2940, 2946, 2952, 2958, 2964, 2970, 2976, 2982, 2988, 2994, 3000, 3006, 3012, 3018, 3024, 3030, 3036, 3042, 3048, 3054, 3060, 3066, 3072, 3078, 3084, 3090, 3096, 3102, 3108, 3114, 3120, 3126, 3132, 3138, 3144, 3150, 3156, 3162, 3168, 3174, 3180, 3186, 3192, 3198, 3204, 3210, 3216, 3222, 3228, 3234, 3240, 3246, 3252, 3258, 3264, 3270, 3276, 3282, 3288, 3294, 3300, 3306, 3312, 3318, 3324, 3330, 3336, 3342, 3348, 3354, 3360, 3366, 3372, 3378, 3384, 3390, 3396, 3402, 3408, 3414, 3420, 3426, 3432, 3438, 3444, 3450, 3456, 3462, 3468, 3474, 3480, 3486, 3492, 3498, 3504, 3510, 3516, 3522, 3528, 3534, 3540, 3546, 3552, 3558, 3564, 3570, 3576, 3582, 3588, 3594, 3600, 3606, 3612, 3618, 3624, 3630, 3636, 3642, 3648, 3654, 3660, 3666, 3672, 3678, 3684, 3690, 3696, 3702, 3708, 3714, 3720, 3726, 3732, 3738, 3744, 3750, 3756, 3762, 3768, 3774, 3780, 3786, 3792, 3798, 3804, 3810, 3816, 3822, 3828, 3834, 3840, 3846, 3852, 3858, 3864, 3870, 3876, 3882, 3888, 3894, 3900, 3906, 3912, 3918, 3924, 3930, 3936, 3942, 3948, 3954, 3960, 3966, 3972, 3978, 3984, 3990, 3996, 4002, 4008, 4014, 4020, 4026, 4032, 4038, 4044, 4050, 4056, 4062, 4068, 4074, 4080, 4086, 4092, 4098, 4104, 4110, 4116, 4122, 4128, 4134, 4140, 4146, 4152, 4158, 4164, 4170, 4176, 4182, 4188, 4194, 4200, 4206, 4212, 4218, 4224, 4230, 4236, 4242, 4248, 4254, 4260, 4266, 4272, 4278, 4284, 4290, 4296, 4302, 4308, 4314, 4320, 4326, 4332, 4338, 4344, 4350, 4356, 4362, 4368, 4374, 4380, 4386, 4392, 4398, 4404, 4410, 4416, 4422, 4428, 4434, 4440, 4446, 4452, 4458, 4464, 4470, 4476, 4482, 4488, 4494, 4500, 4506, 4512, 4518, 4524, 4530, 4536, 4542, 4548, 4554, 4560, 4566, 4572, 4578, 4584, 4590, 4596, 4602, 4608, 4614, 4620, 4626, 4632, 4638, 4644, 4650, 4656, 4662, 4668, 4674, 4680, 4686, 4692, 4698, 4704, 4710, 4716, 4722, 4728, 4734, 4740, 4746, 4752, 4758, 4764, 4770, 4776, 4782, 4788, 4794, 4800, 4806, 4812, 4818, 4824, 4830, 4836, 4842, 4848, 4854, 4860, 4866, 4872, 4878, 4884, 4890, 4896, 4902, 4908, 4914, 4920, 4926, 4932, 4938, 4944, 4950, 4956, 4962, 4968, 4974, 4980, 4986, 4992, 4998, 5004, 5010, 5016, 5022, 5028, 5034, 5040, 5046, 5052, 5058, 5064, 5070, 5076, 5082, 5088, 5094, 5100, 5106, 5112, 5118, 5124, 5130, 5136, 5142, 5148, 5154, 5160, 5166, 5172, 5178, 5184, 5190, 5196, 5202, 5208, 5214, 5220, 5226, 5232, 5238, 5244, 5250, 5256, 5262, 5268, 5274, 5280, 5286, 5292, 5298, 5304, 5310, 5316, 5322, 5328, 5334, 5340, 5346, 5352, 5358, 5364, 5370, 5376, 5382, 5388, 5394, 5400, 5406, 5412, 5418, 5424, 5430, 5436, 5442, 5448, 5454, 5460, 5466, 5472, 5478, 5484, 5490, 5496, 5502, 5508, 5514, 5520, 5526, 5532, 5538, 5544, 5550, 5556, 5562, 5568, 5574, 5580, 5586, 5592, 5598, 5604, 5610, 5616, 5622, 5628, 5634, 5640, 5646, 5652, 5658, 5664, 5670, 5676, 5682, 5688, 5694, 5700, 5706, 5712, 5718, 5724, 5730, 5736, 5742, 5748, 5754, 5760, 5766, 5772, 5778, 5784, 5790, 5796, 5802, 5808, 5814, 5820, 5826, 5832, 5838, 5844, 5850, 5856, 5862, 5868, 5874, 5880, 5886, 5892, 5898, 5904, 5910, 5916, 5922, 5928, 5934, 5940, 5946, 5952, 5958, 5964, 5970, 5976, 5982, 5988, 5994, 6000, 6006, 6012, 6018, 6024, 6030, 6036, 6042, 6048, 6054, 6060, 6066, 6072, 6078, 6084, 6090, 6096, 6102, 6108, 6114, 6120, 6126, 6132, 6138, 6144, 6150, 6156, 6162, 6168, 6174, 6180, 6186, 6192, 6198, 6204, 6210, 6216, 6222, 6228, 6234, 6240, 6246, 6252, 6258, 6264, 6270, 6276, 6282, 6288, 6294, 6300, 6306, 6312, 6318, 6324, 6330, 6336, 6342, 6348, 6354, 6360, 6366, 6372, 6378, 6384, 6390, 6396, 6402, 6408, 6414, 6420, 6426, 6432, 6438, 6444, 6450, 6456, 6462, 6468, 6474, 6480, 6486, 6492, 6498, 6504, 6510, 6516, 6522, 6528, 6534, 6540, 6546, 6552, 6558, 6564, 6570, 6576, 6582, 6588, 6594, 6600, 6606, 6612, 6618, 6624, 6630, 6636, 6642, 6648, 6654, 6660, 6666, 6672, 6678, 6684, 6690, 6696, 6702, 6708, 6714, 6720, 6726, 6732, 6738, 6744, 6750, 6756, 6762, 6768, 6774, 6780, 6786, 6792, 6798, 6804, 6810, 6816, 6822, 6828, 6834, 6840, 6846, 6852, 6858, 6864, 6870, 6876, 6882, 6888, 6894, 6900, 6906, 6912, 6918, 6924, 6930, 6936, 6942, 6948, 6954, 6960, 6966, 6972, 6978, 6984, 6990, 6996, 7002, 7008, 7014, 7020, 7026, 7032, 7038, 7044, 7050, 7056, 7062, 7068, 7074, 7080, 7086, 7092, 7098, 7104, 7110, 7116, 7122, 7128, 7134, 7140, 7146, 7152, 7158, 7164, 7170, 7176, 7182, 7188, 7194, 7200, 7206, 7212, 7218, 7224, 7230, 7236, 7242, 7248, 7254, 7260, 7266, 7272, 7278, 7284, 7290, 7296, 7302, 7308, 7314, 7320, 7326, 7332, 7338, 7344, 7350, 7356, 7362, 7368, 7374, 7380, 7386, 7392, 7398, 7404, 7410, 7416, 7422, 7428, 7434, 7440, 7446, 7452, 7458, 7464, 7470, 7476, 7482, 7488, 7494, 7500, 7506, 7512, 7518, 7524, 7530, 7536, 7542, 7548, 7554, 7560, 7566, 7572, 7578, 7584, 7590, 7596, 7602, 7608, 7614, 7620, 7626, 7632, 7638, 7644, 7650, 7656, 7662, 7668, 7674, 7680, 7686, 7692, 7698, 7704, 7710, 7716, 7722, 7728, 7734, 7740, 7746, 7752, 7758, 7764, 7770, 7776, 7782, 7788, 7794, 7800, 7806, 7812, 7818, 7824, 7830, 7836, 7842, 7848, 7854, 7860, 7866, 7872, 7878, 7884, 7890, 7896, 7902, 7908, 7914, 7920, 7926, 7932, 7938, 7944, 7950, 7956, 7962, 7968, 7974, 7980, 7986, 7992, 7998, 8004, 8010, 8016, 8022, 8028, 8034, 8040, 8046, 8052, 8058, 8064, 8070, 8076, 8082, 8088, 8094, 8100, 8106, 8112, 8118, 8124, 8130, 8136, 8142, 8148, 8154, 8160, 8166, 8172, 8178, 8184, 8190, 8196, 8202, 8208, 8214, 8220, 8226, 8232, 8238, 8244, 8250, 8256, 8262, 8268, 8274, 8280, 8286, 8292, 8298, 8304, 8310, 8316, 8322, 8328, 8334, 8340, 8346, 8352, 8358, 8364, 8370, 8376, 8382, 8388, 8394, 8400, 8406, 8412, 8418, 8424, 8430, 8436, 8442, 8448, 8454, 8460, 8466, 8472, 8478, 8484, 8490, 8496, 8502, 8508, 8514, 8520, 8526, 8532, 8538, 8544, 8550, 8556, 8562, 8568, 8574, 8580, 8586, 8592, 8598, 8604, 8610, 8616, 8622, 8628, 8634, 8640, 8646, 8652, 8658, 8664, 8670, 8676, 8682, 8688, 8694, 8700, 8706, 8712, 8718, 8724, 8730, 8736, 8742, 8748, 8754, 8760, 8766, 8772, 8778, 8784, 8790, 8796, 8802, 8808, 8814, 8820, 8826, 8832, 8838, 8844, 8850, 8856, 8862, 8868, 8874, 8880, 8886, 8892, 8898, 8904, 8910, 8916, 8922, 8928, 8934, 8940, 8946, 8952, 8958, 8964, 8970, 8976, 8982, 8988, 8994, 9000, 9006, 9012, 9018, 9024, 9030, 9036, 9042, 9048, 9054, 9060, 9066, 9072, 9078, 9084, 9090, 9096, 9102, 9108, 9114, 9120, 9126, 9132, 9138, 9144, 9150, 9156, 9162, 9168, 9174, 9180, 9186, 9192, 9198, 9204, 9210, 9216, 9222, 9228, 9234, 9240, 9246, 9252, 9258, 9264, 9270, 9276, 9282, 9288, 9294, 9300, 9306, 9312, 9318, 9324, 9330, 9336, 9342, 9348, 9354, 9360, 9366, 9372, 9378, 9384, 9390, 9396, 9402, 9408, 9414, 9420, 9426, 9432, 9438, 9444, 9450, 9456, 9462, 9468, 9474, 9480, 9486, 9492, 9498, 9504, 9510, 9516, 9522, 9528, 9534, 9540, 9546, 9552, 9558, 9564, 9570, 9576, 9582, 9588, 9594, 9600, 9606, 9612, 9618, 9624, 9630, 9636, 9642, 9648, 9654, 9660, 9666, 9672, 9678, 9684, 9690, 9696, 9702, 9708, 9714, 9720, 9726, 9732, 9738, 9744, 9750, 9756, 9762, 9768, 9774, 9780, 9786, 9792, 9798, 9804, 9810, 9816, 9822, 9828, 9834, 9840, 9846, 9852, 9858, 9864, 9870, 9876, 9882, 9888, 9894, 9900, 9906, 9912, 9918, 9924, 9930, 9936, 9942, 9948, 9954, 9960, 9966, 9972, 9978, 9984, 9990, 9996, 10002, 10008, 10014, 10020, 10026, 10032, 10038, 10044, 10050, 10056, 10062, 10068, 10074, 10080, 10086, 10092, 10098, 10104, 10110, 10116, 10122, 10128, 10134, 10140, 10146, 10152, 10158, 10164, 10170, 10176, 10182, 10188, 10194, 10200, 10206, 10212, 10218, 10224, 10230, 10236, 10242, 10248, 10254, 10260, 10266, 10272, 10278, 10284, 10290, 10296, 10302, 10308, 10314, 10320, 10326, 10332, 10338, 10344, 10350, 10356, 10362, 10368, 10374, 10380, 10386, 10392, 10398, 10404, 10410, 10416, 10422, 10428, 10434, 10440, 10446, 10452, 10458, 10464, 10470, 10476, 10482, 10488, 10494, 10500, 10506, 10512, 10518, 10524, 10530, 10536, 10542, 10548, 10554, 10560, 10566, 10572, 10578, 10584, 10590, 10596, 10602, 10608, 10614, 10620, 10626, 10632, 10638, 10644, 10650, 10656, 10662, 10668, 10674, 10680, 10686, 10692, 10698, 10704, 10710, 10716, 10722, 10728, 10734, 10740, 10746, 10752, 10758, 10764, 10770, 10776, 10782, 10788, 10794, 10800, 10806, 10812, 10818, 10824, 10830, 10836, 10842, 10848, 10854, 10860, 10866, 10872, 10878, 10884, 10890, 10896, 10902, 10908, 10914, 10920, 10926, 10932, 10938, 10944, 10950, 10956, 10962, 10968, 10974, 10980, 10986, 10992, 10998, 11004, 11010, 11016, 11022, 11028, 11034, 11040, 11046, 11052, 11058, 11064, 11070, 11076, 11082, 11088, 11094, 11100, 11106, 11112, 11118, 11124, 11130, 11136, 11142, 11148, 11154, 11160, 11166, 11172, 11178, 11184, 11190, 11196, 11202, 11208, 11214, 11220, 11226, 11232, 11238, 11244, 11250, 11256, 11262, 11268, 11274, 11280, 11286, 11292, 11298, 11304, 11310, 11316, 11322, 11328, 11334, 11340, 11346, 11352, 11358, 11364, 11370, 11376, 11382, 11388, 11394, 11400, 11406, 11412, 11418, 11424, 11430, 11436, 11442, 11448, 11454, 11460, 11466, 11472, 11478, 11484, 11490, 11496, 11502, 11508, 11514, 11520, 11526, 11532, 11538, 11544, 11550, 11556, 11562, 11568, 11574, 11580, 11586, 11592, 11598, 11604, 11610, 11616, 11622, 11628, 11634, 11640, 11646, 11652, 11658, 11664, 11670, 11676, 11682, 11688, 11694, 11700, 11706, 11712, 11718, 11724, 11730, 11736, 11742, 11748, 11754, 11760, 11766, 11772, 11778, 11784, 11790, 11796, 11802, 11808, 11814, 11820, 11826, 11832, 11838, 11844, 11850, 11856, 11862, 11868, 11874, 11880, 11886, 11892, 11898, 11904, 11910, 11916, 11922, 11928, 11934, 11940, 11946, 11952, 11958, 11964, 11970, 11976, 11982, 11988, 11994, 12000, 12006, 12012, 12018, 12024, 12030, 12036, 12042, 12048, 12054, 12060, 12066, 12072, 12078, 12084



## Protein

Protein composition is directly affected by environmental and hereditary and probably by soil pH. It is hereditarily determined within a relatively narrow range by genotype determined the composition according to genetic purpose apparent. The problem is further complicated by evidence of natural selection (Wolfe, 1947) and divergence in modes of inheritance in which the same character may follow different patterns of inheritance in various lines within the same species (Wolfe, 1947).

Ample field evidence points to the fact that the soil pH is the most important factor influencing protein content in the soil. Cultural practices such as the rate and time of fertilizer application influence protein content of many cereal grains (Hargreaves et al., 1941). Increased protein content with increased application increases the protein fraction of the grain. The most desirable situation and situation is the one in which the protein content is high (Hargreaves et al., 1941). Hargreaves et al. (1941) reported high protein grain crops (Hargreaves et al., 1941) obtained with a most efficient and complete utilization of nitrogen from the plant to the grain (Hargreaves et al., 1941) differential nitrogen uptake or assimilation by the plant.

various, different, and some other factors, such as the "dosage" of the genes, is affected by environmental factors. The *genotype-environment* interaction must be considered in a broader perspective. This concept was introduced by Lush (1942) and by Huxley (1942). Lush (1942) and Huxley (1942) are the first to mention the phenotypic expression of protein synthesis. The phenotypic expression of protein synthesis is a balance between the genetic component, the environmental conditions, and the interaction between the two.

The results of this study are further evidence of the complex nature of protein metabolism. The significance of environmental differences due to location appears to be masked by other interactions.

Environmental differences were present, but the effect of environment across 12 different genotypes masked this effect. Any statistical analysis of an experiment involving multiple analysis should, therefore, partition the variance into all possible interactions.

Differences between replications in each district were not explained. Seed used is growing the same way with seeds from the same land, same variation is observed. It is likely that possible differences in genotype of the parents. This is also verified by the analysis of

and the  $\chi^2$  test for independence (Table III). Based on prior information, however, the observed frequencies for the light, non-replicating group are unknown for some sites within the 1961-1962 and 1962-1963 seasons.

From examination of the data collected for specific years, it is evident that the conclusions and inferences made from the  $\chi^2$  test are: (a) no individual plots with replication (replicates) repeated the Delany Beach location has been visited for number found in Ocracokeville. Further examination reveals that in every case within Lane T-4 and the 1968 or 1969 lines are observed. These same lines were divergent reciprocal variances across locations (Table III and III). It may be hypothesized that some environmental effect or environmental interaction is occurring, when these data are considered in the light of some of the material effect as indicated by the results of genetic parameters (Table III). Environmental conditions caused the higher incidence of replication observed at Delany Beach are unknown.

Examination of material effects as indicated by the data revealed a significant reciprocal variance at both locations. Reciprocal variance estimates indicate that lines 1968-1969 and 1969-1970 are responsible for most of the variance due to material effect with either Lane T-4 replicating some of the Delany Beach or Lane T-48 at Ocracokeville. These

environment) reflect an particular feeding behavior. The feeding behavior is determined by numerous factors (1).

#### CONCLUSIONS

The feeding behavior of the insects affects and even determines the amount of insecticide the body of the insect can tolerate and excrete in the grain. Any program for insect control should examine not only resistance, but also feeding behavior. These factors influence not only the amount of insecticide but also whether a chosen insect should be sprayed by day or the female parent.

Field research has played a great deal of stress on resistance, estimates the specific genetic traits. Correlations, however, are valid only where extensive research has been done with data pooled over genotypes (1, 2, 3). Correlations are where specific genotypes and locations are used (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100).

Resistance is estimates of heritability for protein resistance, unique in insects. Cook and Condy (1971) used heritability estimates for this trait in sorghum. Various methods of calculations and with the population (1971) found components of additive, dominance and epistasis significantly different between locations. In insects, again, in turn, protein is significantly different. Protein is significantly different between locations.

and (2) the correlation between the observed and the expected frequencies was tested. The chi-square test for independence revealed by Akai (1988), (1992) and Akai (1993) that the results to show in this study. The results of the chi-square test were not statistically significant, indicating that the observed frequencies did not differ significantly from the expected frequencies. Environmental education is a complex process and the variability in student's responses is expected.

conclusion is that work indicates that analysis for *pathways of control* prove inadequate when working with a continuously-increased trait. It should be one of a *continuously-increased* slope leading toward a better and a *discontinued* in the actions involved is the inheritance of *control*. Only through such analysis can we discover *control* systems that *get on* is controlled by a major gene and *get on* is *it* is on the way of many genes, each of which *control* the synthesis of a particular amino acid with *connection* between control mechanisms.

limited data on lysine utilization make detailed dietary adjustments impossible. Certain correlations can be made, and may be useful in the formulation of hypotheses, in future trials.

However, higher quality is accompanied by lower value.





## conclusions

The inheritance of protein in parallel is influenced mainly by presence of dominance for low protein with additive conditional effects which are affected by environmental factors. Her. data need be collected to estimate their effect and their significance in a breeding program.

The inheritance of lysine may be influenced by the presence of dominance as seen from Table III. Lack of consistent replacement predicted estimation of average additive effects. Regression analysis indicated selection for high shell protein may have little effect on total essential amino acids but have a negative effect on  $\alpha$ -amino acids, glutamic and threonine.

Some quantitative analytical techniques for lysine are available when applied to parallel as this work shows that a breeding for quail with higher protein quality requires careful control with this deficiency in resources.

### Biographical Sketch

Long, Lynn Everett was born July 19, 1931, at Memphis, Tennessee. He attended high school at Memphis Technical High School and the University of Tennessee Junior College at Knoxville, Tennessee, in 1949.

He joined the U. S. Marine Corps at the outbreak of the Korean Conflict and was sent to Korea after basic training and training as a radio operator. He rose to the rank of second lieutenant and in 1953 was recommended for commissioning and promoted to first lieutenant for demonstrating leadership in the field. He was commissioned in March of 1953 at Fort Belvoir, Illinois. He was assigned to the 1st Marine Division, 1st Marine Airborne Task Force, at Da Nang, Vietnam, in December of 1954. He was released from active duty in 1955 with the rank of first lieutenant and was honorably discharged in 1956 at the rank of captain.

He returned to Tennessee upon release from active duty and attended the University of Tennessee at Knoxville where he received a B.S. degree in Business Administration in 1957. He then assumed management responsibilities of a family business at Knoxville, Tennessee, upon graduation, and was employed at Knoxville Arsenal with the mobile industry until the early 1960s and accepted employment in

and the *Journal of Applied Behavior Analysis* as a backbone

[illegible]

001) Barrett attended Harrag State University, "Harrag-  
002) University," Harrag, for foreign post (1948-1951), and began work  
003) as a Master of Science degree in agriculture. He and his  
004) followed to Mexico in 1952. The Presbyterian Church  
005) in Mexico voted at that time to request that all missionaries  
006) removed from Mexico to allow complete autonomy. He  
007) returned to Harrag in Harrag State University in 1953 and  
008) completed work on his Master of Science Degree in August,  
009) 1954.

Mr. Farnett began work toward a Ph.D. in Genetics in 1951 at the University of Florida. He taught the Genetics course at UFL until his quarters and wrote the manual which is now being used in that quarter. He taught the genetics course at UFL during the fall of 1954.

the following table, grouped under (19a)–(19c), the first column

(19a) (19b) (19c) (19d) (19e) (19f) (19g) (19h) (19i) (19j)

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly composition and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Rex L. Smith  
Rex L. Smith, Chairman  
Associate Professor of Agronomy

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly composition and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

James Soule  
James Soule  
Professor of Fruit Crops

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly composition and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Victor E. Smith, Jr.  
Victor E. Smith, Jr.  
Professor of Agronomy

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly composition and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Ralph C. Robinson  
Ralph C. Robinson  
Associate Professor of Fruit Science

and I therefore have strong doubts. There  
is no one to whom we can appeal as an authority on the subject  
of the degree of degree of degree.

Robert J. Bell  
Robert J. Bell  
Assistant Professor of Statistics

This dissertation was submitted to the Graduate Faculty of  
the College of Agriculture and to the Graduate Council, and  
was approved as partial fulfillment of the requirements for  
the degree of Master of Philosophy.

June, 1975

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Dean, Graduate School